Fast Computation of Frequency Response of Cavity-Backed Apertures Using MBPE in Conjunction with Hybrid FEM/MoM Technique

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ABSTRACT

The hybrid Finite Element Method(FEM)/Method of Moments(MoM) technique has become popular over the last few years due to its flexibility to handle arbitrarily shaped objects with complex materials. One of the disadvantages of this technique, however, is the computational cost involved in obtaining solutions over a frequency range as computations are repeated for each frequency. In this paper, the application of Model Based Parameter Estimation (MBPE) method[1] with the hybrid FEM/MoM technique is presented for fast computation of frequency response of cavity-backed apertures[2,3]. In MBPE, the electric field is expanded in a rational function of two polynomials. The coefficients of the rational function are obtained using the frequency-derivatives of the integro-differential equation formed by the hybrid FEM/MoM technique. Using the rational function approximation, the electric field is calculated at different frequencies from which the frequency response is obtained.

In figure 1, the frequency response for the RCS of a rectangular cavity in an infinite ground plane is presented. Numerical data obtained from MBPE calculations agree well with the values computed at each frequency over the frequency range. The MBPE method required 380 secs of CPU time to calculate the frequency response, whereas the calculations performed at 13 individual frequency points required 2,400 secs of CPU time. In figure 2, the normalized input impedance of a cavity-backed circular microstrip patch antenna is presented. For this case, MBPE required 913 secs of CPU time to calculate the frequency response, whereas the calculations at 15 frequency points required around 6,375 secs of CPU time. MBPE is clearly found to be superior in terms of CPU time to obtain the frequency response of cavity-backed apertures. More numerical examples and a discussion on limitations of the MBPE method will be presented at the meeting.

References:

[1] G.J.Burke, E.K.Miller, S.Chakrabarthi and K.Demarest, “Using model-based parameter estimation to increase the efficiency of computing electromagnetic transfer functions,” *IEEE Trans. Magnetics*, Vol.25, pp.2807-2809, July 1989.

[2] C.R.Cockrell and F.B.Beck, “Asymptotic Waveform Evaluation (AWE) technique for frequency domain electromagnetic analysis,” *NASA Technical Memorandum 110292*, November 1996.

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[3] C.J.Reddy, "Application of model based parameter estimation for fast frequency response calculations of input characteristics of cavity-backed aperture antennas using hybrid FEM/ MoM technique," in press as *NASA Contractor Report.*

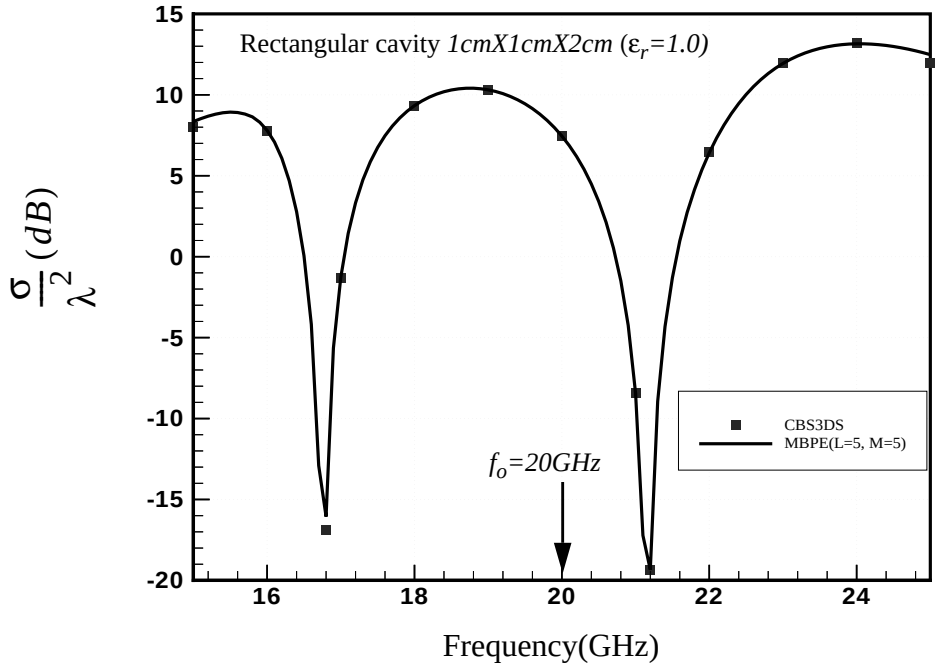

Figure 1 Frequency response calculation for RCS of a rectangular cavity in an infinite ground plane.

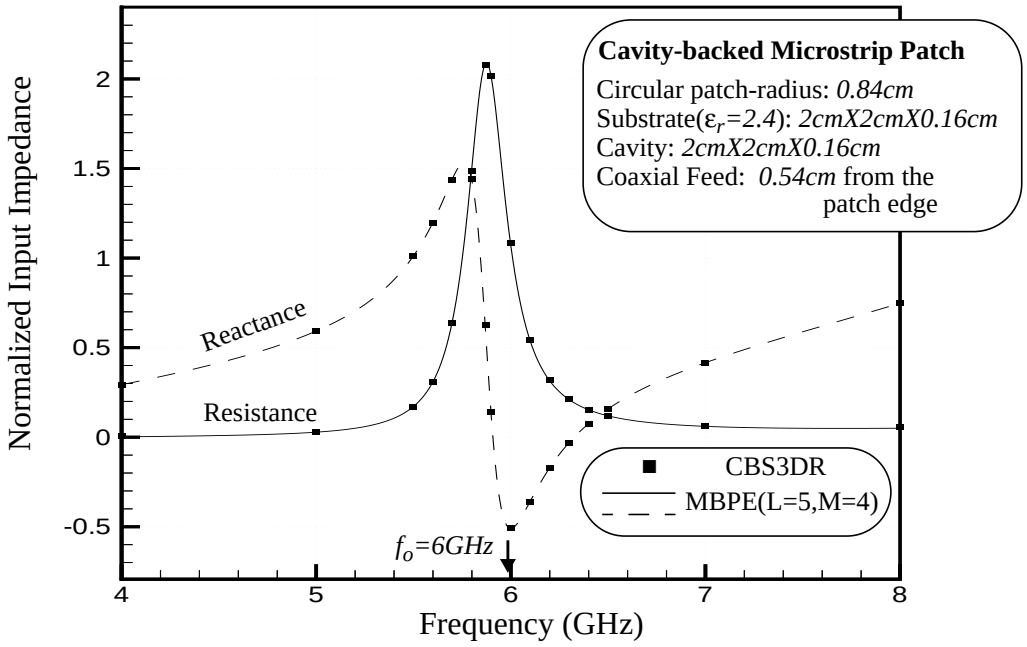

Figure 2 Frequency response calculation for input impedance of a cavity-backed circular microstrip patch.